

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

De Carli, Elda
DE CARLI, Elda
Cryovac S.p.A.
Via Trento, 7
I-20017 Passirana di Rho
ITALIE

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing
(day/month/year) 05.06.2000

Applicant's or agent's file reference
D-43072-01

IMPORTANT NOTIFICATION

International application No.
PCT/EP99/07338

International filing date (day/month/year)
04/10/1999

Priority date (day/month/year)
19/10/1998

Applicant
CRYOVAC, INC. et al.


1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/

 European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer

Ridé, M-C

Tel. +49 89 2399-6082



PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference D-43072-01	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/ISPEA/418)	
International application No. PCT/EP99/07338	International filing date (day/month/year) 04/10/1999	Priority date (day/month/year) 19/10/1998
International Patent Classification (IPC) or national classification and IPC B32B5/32		
Applicant CRYOVAC, INC. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 4 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 07/04/2000	Date of completion of this report 05.06.2000
Name and mailing address of the International preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Schambeck, W Telephone No. +49 89 2399 2135 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/EP99/07338

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-11 as originally filed

Claims, No.:

1-11 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:**III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability**

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

- ☐ the entire international application.
☒ claims Nos. 10.

because:

- ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/EP99/07338

- ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):
- ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.
- ☒ no international search report has been established for the said claims Nos. 10.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Yes:	Claims 1-9, 11
	No:	Claims
Inventive step (IS)	Yes:	Claims 1-9, 11
	No:	Claims
Industrial applicability (IA)	Yes:	Claims 1-9, 11
	No:	Claims

2. Citations and explanations

see separate sheet

INTERNATIONAL PRELIMINARY

International application No. PCT/EP99/07338

EXAMINATION REPORT - SEPARATE SHEET

1. The claimed invention is to be regarded as being novel because no disclosure can be found in the documents cited in the search report of a thermoformable sheet comprising a first polypropylene foam layer and a second polypropylene foam layer and wherein the polypropylene of the first layer and the polypropylene of the second layer differ in flexural modulus.

2. The claimed invention is to be regarded as involving an inventive step because it appears credible that the thermoformable sheet for which protection is sought exhibits a good balance of thermoformability and stiffness and no technical information can be taken from the documents cited in the search report which might render the technical success achieved foreseeable.

Annex to Form PCT/ISA/206
COMMUNICATION RELATING TO THE RESULTS
OF THE INTERNATIONAL SEARCH

International Application No.

T/EP 99/07338

1. The present communication is an Annex to the invitation to pay additional fees (Form PCT/ISA/206). It shows the results of the international search established on the parts of the international application which relate to the invention first mentioned in claims Nos.:

1-9, 11

2. This communication is not the international search report which will be established according to Article 18 and Rule 43.

3. If the applicant does not pay any additional search fees, the information appearing in this communication will be considered as the result of the international search and will be included as such in the international search report.

4. If the applicant pays additional fees, the international search report will contain both the information appearing in this communication and the results of the international search on other parts of the international application for which such fees will have been paid.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Section Ch, Week 9518 Derwent Publications Ltd., London, GB; Class A32, AN 95-136446 XP002095160 & JP 07 060816 A (ACHILLES CORP KK), 7 March 1995 (1995-03-07) abstract	1-3
A	--- WO 91 13933 A (JAMES RIVER CORP) 19 September 1991 (1991-09-19) cited in the application claims 19-24 page 22, line 19 - page 23, line 14	1-9, 11
A	--- GB 2 263 435 A (SHELL INT RESEARCH) 28 July 1993 (1993-07-28) claims 1-3, 7, 9 page 3, line 21 - line 26 page 4, line 9 - line 33 example 1	1-9, 11
A	--- EP 0 287 826 A (MITSUBISHI PETROCHEMICAL CO) 26 October 1988 (1988-10-26) column 3, line 54 - column 4, line 18 --- -/-	1-9, 11



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents:

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document but published on or after the international filing date

L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

Z document member of the same patent family

Annex Form PCT/ISA/206
COMMUNICATION RELATING TO THE RESULTS
OF THE PATENT INTERNATIONAL SEARCH

International Application No.

EP 99/07338

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 841 155 A (JSP CORP) 13 May 1998 (1998-05-13) claim 1 page 4, line 31 - line 49 page 4, line 54 -page 5, line 2 page 5, line 29 - line 40 page 5, line 52 - line 57 -----	1-9,11

INVITATION TO PAY ADDITIONAL FEES

International application No.

PCT/EP 99/07338

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-9, 11 (in part)

A thermoformable, multilayer, co-extruded sheet comprising at least 2 PP foam layers obtained by chemical foaming, and having different flexural modulus; additional functional layers can be present (barrier layer, tie layer, heat-sealing layer). A thermoformed article obtained from such a sheet and referring to any preceding claim is also defined in claim 11.

2. Claims: 10, 11 (in part)

A thermoformable, multilayer, coextruded PP foam sheet having a density in the range of 0.5 to 0.85 g/cm³, and a flexural modulus higher than 400 MPa. A thermoformed article obtained from such a sheet and referring to any preceding claim is also defined in claim 11.

In view of claims 1-11 and of the description, the only common concept of the present application is a thermoformable, multilayer, co-extruded PP foam sheet.

This structure is known as it is disclosed in JP7060816 (D1) for example (cf. WPI abstract).

Hence, the common concept is not novel in view of this prior art document.

No other features in the claims or the description could be distinguished which could be considered as same or corresponding technical features in the sense of Rule 13.2 PCT.

Therefore, no single general inventive concept underlying the present set of claims (1 to 11) can be recognized; this application does not meet the requirement of unity of invention - Article 17.3.a) PCT, Rule 13.1 PCT.

Furthermore, the subjective problem to be solved mentioned explicitly in the description by the applicant is to provide a PP foam laminate exhibiting a good balance between thermoformability and stiffness properties. This problem is solved by document (D1) identified above cited as an X document in the search report, whereas it is noted that the flexural modulus is well known as a material property.

2 (two) different non-unitary subjects can now be distinguished, each characterized by special or further technical features of the common concept identified above:

I Such a multilayer material comprising at least 2 PP foam sheets

INVITATION TO PAY ADDITIONAL FEES

International application No.

PCT/EP 99/07338

obtained by chemical foaming, and exhibiting different flexural modulus values, and a thermoformed article obtained therefrom (Claims 1-9, 11 in part)

II Such a multilayer material having a density in the range of 0.5 to 0.85 g/cm³, and a flexural modulus higher than 400 MPa, and a thermoformed article obtained therefrom (Claims 10, 11 in part)

The problems underlying the 2 sets of claims may in both cases be regarded as to provide alternative thermoformable, multilayer coextruded PP foam sheets.

The partial search report has been drawn up for the subject-matter of group I only.

Searching the other invention would have caused major additional effort; therefore the applicant is invited to pay 1 (one) additional fee for the search of group II.

Patent Family Annex

Information on patent family members

Internat

Application No

P 99/07338

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 7060816	A	07-03-1995	NONE	
WO 9113933	A	19-09-1991	US 5116881 A	26-05-1992
			AT 122701 T	15-06-1995
			CA 2078123 A,C	15-09-1991
			DE 69109860 D	22-06-1995
			DE 69109860 T	26-10-1995
			EP 0520028 A	30-12-1992
			ES 2072606 T	16-07-1995
			JP 2638532 B	06-08-1997
			JP 7266413 A	17-10-1995
			JP 2521388 B	07-08-1996
			KR 9603278 B	08-03-1996
			US 5149579 A	22-09-1992
			US 5180751 A	19-01-1993
GB 2263435	A	28-07-1993	NONE	
EP 0287826	A	26-10-1988	JP 7098349 B	25-10-1995
			JP 63252715 A	19-10-1988
			US 4889669 A	26-12-1989
EP 0841155	A	13-05-1998	JP 10138350 A	26-05-1998
			US 5928776 A	27-07-1999

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference D-43072-01	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/EP 99/ 07338	International filing date (day/month/year) 04/10/1999	(Earliest) Priority Date (day/month/year) 19/10/1998
Applicant CRYOVAC, INC. et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 5 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☒ Unity of invention is lacking (see Box II).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

☐ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP 99/07338

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-9,11 (part.)

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

1. Claims: 1-9, 11 (in part)

A thermoformable, multilayer, co-extruded sheet comprising at least 2 PP foam layers obtained by chemical foaming, and having different flexural modulus; additional functional layers can be present (barrier layer, tie layer, heat-sealing layer). A thermoformed article obtained from such a sheet and referring to any preceding claim is also defined in claim 11.

2. Claims: 10, 11 (in part)

A thermoformable, multilayer, coextruded PP foam sheet having a density in the range of 0.5 to 0.85 g/cm³, and a flexural modulus higher than 400 MPa. A thermoformed article obtained from such a sheet and referring to any preceding claim is also defined in claim 11.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 99/07338

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B32B5/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Section Ch, Week 9518 Derwent Publications Ltd., London, GB; Class A32, AN 95-136446 XP002095160 & JP 07 060816 A (ACHILLES CORP KK), 7 March 1995 (1995-03-07) abstract	1-3
A	--- WO 91 13933 A (JAMES RIVER CORP) 19 September 1991 (1991-09-19) cited in the application claims 19-24 page 22, line 19 -page 23, line 14 --- -/-	1-9,11

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

° Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

6 January 2000

Date of mailing of the international search report

29. 03. 2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Girard, S

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 99/07338

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 263 435 A (SHELL INT RESEARCH) 28 July 1993 (1993-07-28) claims 1-3,7,9 page 3, line 21 - line 26 page 4, line 9 - line 33 example 1 ---	1-9,11
A ✓	EP 0 287 826 A (MITSUBISHI PETROCHEMICAL CO) 26 October 1988 (1988-10-26) column 3, line 54 -column 4, line 18 ---	1-9,11
A ✓	EP 0 841 155 A (JSP CORP) 13 May 1998 (1998-05-13) claim 1 page 4, line 31 - line 49 page 4, line 54 -page 5, line 2 page 5, line 29 - line 40 page 5, line 52 - line 57 -----	1-9,11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 99/07338

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 7060816	A	07-03-1995	NONE	
WO 9113933	A	19-09-1991	US 5116881 A	26-05-1992
			AT 122701 T	15-06-1995
			CA 2078123 A,C	15-09-1991
			DE 69109860 D	22-06-1995
			DE 69109860 T	26-10-1995
			EP 0520028 A	30-12-1992
			ES 2072606 T	16-07-1995
			JP 2638532 B	06-08-1997
			JP 7266413 A	17-10-1995
			JP 2521388 B	07-08-1996
			KR 9603278 B	08-03-1996
			US 5149579 A	22-09-1992
			US 5180751 A	19-01-1993
GB 2263435	A	28-07-1993	NONE	
EP 0287826	A	26-10-1988	JP 7098349 B	25-10-1995
			JP 63252715 A	19-10-1988
			US 4889669 A	26-12-1989
EP 0841155	A	13-05-1998	JP 10138350 A	26-05-1998
			US 5928776 A	27-07-1999

PATENT COOPERATION TREATY

PCT

REC'D 07 JUN 2000

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference D-43072-01	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP99/07338	International filing date (day/month/year) 04/10/1999	Priority date (day/month/year) 19/10/1998
International Patent Classification (IPC) or national classification and IPC B32B5/32		
Applicant CRYOVAC, INC. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.


2. This REPORT consists of a total of 4 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 07/04/2000	Date of completion of this report 05.06.2000
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Schambeck, W Telephone No. +49 89 2399 2135



**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/EP99/07338

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-11 as originally filed

Claims, No.:

1-11 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

- ☐ the entire international application.
☒ claims Nos. 10.

because:

- ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/EP99/07338

- ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):
- ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.
- ☒ no international search report has been established for the said claims Nos. 10.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-9, 11
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-9, 11
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-9, 11
	No:	Claims	

2. Citations and explanations

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/EP99/07338

1. The claimed invention is to be regarded as being novel because no disclosure can be found in the documents cited in the search report of a thermoformable sheet comprising a first polypropylene foam layer and a second polypropylene foam layer and wherein the polypropylene of the first layer and the polypropylene of the second layer differ in flexural modulus.

2. The claimed invention is to be regarded as involving an inventive step because it appears credible that the thermoformable sheet for which protection is sought exhibits a good balance of thermoformability and stiffness and no technical information can be taken from the documents cited in the search report which might render the technical success achieved foreseeable.

PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : B32B 5/32	A1	(11) International Publication Number: WO 00/23270 (43) International Publication Date: 27 April 2000 (27.04.00)
(21) International Application Number: PCT/EP99/07338 (22) International Filing Date: 4 October 1999 (04.10.99) (30) Priority Data: 98119685.0 19 October 1998 (19.10.98) EP (71) Applicant (for all designated States except US): CRYOVAC, INC. [US/US]; 100 Rogers Bridge Road, Duncan, SC 29334 (US). (72) Inventors; and (75) Inventors/Applicants (for US only): DI CESARE, Gregorio [IT/IT]; Via XX Settembre 81, I-20023 Cerro Maggiore (IT). COLNAGHI, Renato [IT/IT]; Via Europa, 18/B, I-20010 Pogliano Milanese (IT). (74) Agent: DE CARLI, Elda; Cryovac S.p.A., Via Trento, 7, I-20017 Passirana di Rho (IT).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
(54) Title: THERMOFORMABLE MULTI-LAYER POLYPROPYLENE FOAM SHEET (57) Abstract A thermoformable, multilayer, co-extruded sheet comprising at least two separate foam polypropylene layers obtained by chemical foaming of two polypropylene resins having different flexural modulus, a "high modulus" polypropylene and a "low modulus" polypropylene. The presence of two different foam layers of polypropylene of different modulus allows obtaining a thermoformable sheet with the desired balance between thermoformability and stiffness.		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

THERMOFORMABLE MULTI-LAYER POLYPROPYLENE FOAM SHEET

The present invention relates to a multi-layer, co-extruded, thermoformable sheet suitable for the production of packaging material.

In particular the present invention relates to a co-extruded, rigid or semi-rigid, sheet
5 comprising at least two polypropylene foam layers, said sheet being thermoformable into shaped articles for packaging.

Thermoforming is a common method for forming trays to be used in the packaging art for holding the products to be packaged. In some cases pre-formed trays are fed to a filling machine which inserts or lays the product to be packaged onto the tray and then either seals on
10 a lid or wrap the loaded tray up. In most of the cases, particularly in the packaging of food products, e.g. fresh red meat or processed meat, a horizontal thermoform-fill-seal machine is employed. Said machine typically requires two separate webs of material, a lower or bottom web and an upper or top web. The lower web must be designed to be easily thermoformable as the machine creates a more-or-less shallow tray therefrom by pulling it across a heated
15 cavity, or die, into which the sheet is drawn by vacuum at temperatures high enough to soften the sheet and allow it to adopt the shape of the cavity without tearing or cracking.

The sheet employed for this purpose therefore must have a good balance between thermoformability, as the speed of the thermoform-fill-seal machine is limited by the time required in the thermoforming step and the appearance of the end package will mainly depend
20 on that of the supporting tray, and stiffness, as the tray should not bend during the packaging process or be distorted by the weight of the packaged product.

In some instances, when a lid is sealed to the tray or the tray rim, the lower web must also be heat-sealable. In some cases it is also required that said thermoformable sheet has a low permeability to gases, in particular oxygen, in order to prolong the shelf-life of oxygen
25 susceptible products, e.g. most of the food products.

Other packaging machines, where an in-line thermoformable lower web is required, are those employed for skin packaging. In these machines the lower web is thermoformed into a tray, the product to be packaged is loaded thereon and the upper web is drawn down by

vacuum all around the product until the film conforms so faithfully to the product contours that it becomes like a skin. Also in this case a thermoformable sheet with a good balance between thermoformability and stiffness is required that preferably has gas barrier properties.

Cast solid sheets are typically employed for these applications. In some cases also foamed sheets are used, as the appearance of a foamed material is well appreciated in the market. One of the problems met with the foamed sheets is to obtain the desired balance between thermoformability and stiffness.

It is an object of the present invention to provide a rigid or semi-rigid foam sheet material that can suitably be thermoformed into a shaped container, such as a tray.

Another object of the present invention is to provide a thermoformable, multi-layer, co-extruded, polypropylene foam sheet having a density ranging from about 0.50 to about 0.85 g/cm³ and a flexural modulus higher than 400 MPa.

A still another object of the present invention is to provide a thermoformable foam sheet material co-extruded with a gas barrier layer for all those applications where a gas barrier packaging material is desired.

It has been found that the above objectives can be achieved by a multi-layer, co-extruded, sheet of thermoplastic material comprising at least two separate layers of foamed polypropylene obtained by chemically foaming polypropylene resins with different flexural modulus.

Polypropylene foam sheets comprising two different layers of foam polypropylene are described in WO 91/13933. More particularly said patent application describes polypropylene foam sheets obtained by physical foaming of a polypropylene resin with certain specific characteristics in terms of M_z , M_z/M_w ratio, J_{e0} (equilibrium compliance) and/or S/S (recoverable shear strain per unit stress). The process there described is a physical process, i.e. a process where foaming is obtained by the use of a blowing agent such as a hydrocarbon, e.g. butane and isopentane, a chlorinated or chloro-fluorinated hydrocarbon, e.g. chloro-difluoromethane, or an inert gas such as nitrogen or carbon dioxide. Generally, however, the use of a hydrocarbon either or a blend of a hydrocarbon with an inert gas obtains physical

foaming. This creates problems of safety during the manufacturing process as well as during stocking of the foamed material. It is in fact necessary to age the foamed material in the warehouses until the trapped blowing gas is evolved and has been replaced by air. Forced ventilation of the warehouses is required and, depending also on the type of blowing agent employed, 5 to 7 days of aging are necessary before the foamed product can be distributed to customers.

WO 91/13933 also refers to the manufacture of a multi-layer foam sheet comprising a functional layer sandwiched between two polypropylene foam layers, possibly with tie layers bonding the foam polypropylene layer to the functional one. The process there schematically described provides for a co-extrusion where the same polypropylene material is foam extruded into two different layers and the foaming is always a physical foaming, with the drawbacks indicated above.

DETAILED DESCRIPTION OF THE INVENTION

A first object of the present invention is a thermoformable, multi-layer, co-extruded sheet comprising at least two separate foam polypropylene layers obtained by chemical foaming of two different polypropylene resins having different flexural modulus, a "high modulus" polypropylene and a "low modulus" polypropylene.

The flexural modulus of the "low modulus" polypropylene resin must be lower than 1,500 MPa, preferably $\leq 1,400$ MPa, and even more preferably $\leq 1,300$ MPa. Examples of "low modulus" polypropylene resins are for instance those commercially available from Montell as Polypropylene KF 6100 (Flexural Modulus, evaluated by ISO Standard Method 178, of about 1,300 MPa) and Polypropylene YX37F (Flexural Modulus of about 1,200 MPa).

The flexural modulus of the "high modulus" polypropylene resin must be $\geq 1,500$ MPa. Preferably it will be $\geq 1,650$ MPa, and even more preferably $\geq 1,800$ MPa. Examples of "high modulus" polypropylene resins are those commercially available from Montell as Adstif™ 680 ADXP (Flexural Modulus of 2,150 MPa) and Adstif™ 699 ADXP (Flexural Modulus of 1,950 MPa).

In the multi-layer co-extruded sheet of the present invention the two foam polypropylene

layers are separated by at least one substantially unfoamed layer. Any thermoplastic material or blend of thermoplastic materials can suitably be employed for said substantially unfoamed layer. The term "substantially unfoamed" is used herein to identify a layer that has not been submitted to a chemical foaming, i.e. that has not been admixed with a chemical foaming agent before extrusion. This term does not exclude, in particular for those layers that are directly adhered to the foam polypropylene layers, that the evolution of gas in the adjacent layers might give rise to a certain, non-substantial, foaming also in these layers.

In case the material or blend of materials used for said layer would not adhere to the foam polypropylene layers with a sufficient bond, tie or adhesive layers may be employed to increase said bond and prevent possible delamination problems.

In one preferred embodiment of the present invention recycle material is incorporated into said substantially unfoamed layer to give additional bulk to the sheet.

In a more preferred embodiment however said substantially unfoamed layer is a gas barrier layer, i.e. a layer of a suitably selected polymeric material and of the suitably selected thickness to provide for an overall multi-layer sheet with an oxygen permeability lower than 200 cm³/m².day.atm, preferably lower than 150 cm³/m².day.atm, more preferably lower than 125 cm³/m².day.atm, and even more preferably lower than 100 cm³/m².day.atm.

Suitable resins for use in said functional layer are preferably ethylene-vinyl alcohol copolymers (EVOH), vinylidene chloride copolymers (PVDC), polyamides, and blends of one or more EVOH with one or more polyamides.

As used herein, "EVOH" refers to ethylene-vinyl alcohol copolymers. EVOH includes saponified or hydrolyzed ethylene-vinyl acetate copolymers, and refers to vinyl alcohol copolymers having an ethylene comonomer content preferably comprised from about 28 to about 48 mole %, more preferably, from about 32 to about 44 mole % ethylene, and even more preferably, from about 38 to about 44 mole % ethylene, and a saponification degree of at least 85 %, preferably at least 90 %.

As used herein the term PVDC refers to a vinylidene chloride copolymer wherein a major amount of the copolymer comprises vinylidene chloride and a minor amount of the copolymer

comprises one or more unsaturated monomers copolymerisable therewith, typically vinyl chloride, and alkyl acrylates or methacrylates (e.g. methyl acrylate or methacrylate) or to a blend thereof in different proportions. Generally said PVDC contains plasticisers and/or stabilisers as known in the art.

5 As used herein, the term polyamide is intended to refer to both polyamides and co-or ter-polyamides. This term specifically includes aliphatic polyamides or co-polyamides, aromatic polyamides or co-polyamides, and partially aromatic polyamides or co-polyamides, modifications thereof and blends thereof.

In case one of the above gas barrier materials is employed for the substantially unfoamed
10 layer, tie layers will be present to increase the bond between said layer and the foam polypropylene ones. Suitable tie layers will preferably comprise modified polyolefins, and more preferably modified polypropylene, modified polyethylene, and modified ethylene co-polymers, such as modified ethylene- α -olefin copolymers, and modified ethylene-unsaturated ester copolymers, e.g. modified ethylene-vinyl acetate copolymers.

15 As used herein the term "modified", when referred to any polyolefin, is inclusive of modified polymer prepared by copolymerizing the homopolymer of the olefin or copolymer thereof with an unsaturated carboxylic acid, e.g., maleic acid, fumaric acid or the like, or a derivative thereof such as the anhydride, ester or metal salt or the like; or by incorporating into the olefin homopolymer or copolymer, an unsaturated carboxylic acid, e.g., maleic acid, fumaric
20 acid or the like, or a derivative thereof such as the anhydride, ester or metal salt or the like. Examples of suitable modified polyolefins are in particular polymers having an anhydride functionality, as defined above, grafted thereon and/or copolymerized therewith and/or blended therewith, wherein preferably, such modified polymers have the anhydride functionality grafted on or polymerized therewith, as opposed to merely blended therewith.

25 In a preferred embodiment the present invention relates to a thermoformable, multi-layer, co-extruded sheet comprising at least two separate foam polypropylene layers obtained by chemical foaming of two polypropylene resins having different flexural modulus, a "high modulus" polypropylene and a "low modulus" polypropylene, sandwiching a gas barrier layer

comprising a polymer selected from the group consisting of ethylene-vinyl alcohol copolymers (EVOH), vinylidene chloride copolymers (PVDC), polyamides, and blends of one or more EVOH and one or more polyamides, bonded to said foam polypropylene layers by means of tie layers.

5 The thickness of the overall thermoformable sheet of the present invention is typically comprised between about 400 and about 1,300 μm . For most of the conventional applications a preferred thickness is in the range of from about 500 to about 1,000 μm , with a most preferred thickness in the range of from about 600 to about 900 μm .

The thickness of each of the foamed polypropylene layers may range from about 100 to
10 about 700 μm , and is preferably comprised between about 150 and about 550 μm , and more preferably between about 200 and about 400 μm . Generally the optimum thickness of the "low modulus" and of the "high modulus" polypropylene layers and their ratio depends on the numerical values thereof and could be easily determined, by trial and error, bearing in mind that the flexural modulus of the end multi-layer sheet should be higher than 400 MPa,
15 preferably higher than 500 MPa, and even more preferably higher than 600 MPa.

When the substantially unfoamed layer separating the two polypropylene foam layers is not a functional layer, its thickness is not critical. Layers as thin as few μm 's or as thick as 250, 300, 350, or more μm can be present.

When the substantially unfoamed layer is a functional layer, its thickness is generally
20 controlled and comprised between about 5 and about 50 μm , preferably between about 6 and about 40 μm , and even more preferably between about 7 and about 30 μm . The thickness of said functional layer should in fact be high enough to guarantee the desired maximum oxygen permeability of the end sheet, but, mainly in view of the cost of the raw polymers, should not be considerably higher than that.

25 The thickness of the tie layers, as usual, will be limited to few μm 's i.e. what is generally needed to provide for the desired bond. As foaming does modify the polymer surface at the interface with the adjacent layers, it is generally required a slightly higher thickness of the tie layers with respect to the corresponding unfoamed structure, e.g. typically up to about 20 μm .

Even when an end sheet is obtained wherein the two-foamed polypropylene layers are both outer layers, the structure is not symmetrical owing to the different modulus of the two polypropylene layers. Thermoforming of this structure needs to be carried out in such a way that the "low modulus" polypropylene layer is the layer in contact with the die cavity and the "high modulus" polypropylene layer is the upper layer in direct contact with the product to be packaged.

When the thermoformable sheet according to the present invention is used in a packaging process that comprises sealing of an upper web or lid to the tray surface, it would be highly desirable to have a heat-sealing layer adhered on the outer surface of the foamed "high modulus" polypropylene layer.

As used herein the term "adhered", as applied to sheet layers, includes both direct adherence of the subject layer to the other layer referred to or to the other two layers the subject layer is between, as well as a lack of direct adherence, i.e., one or more additional layers can be imposed between the subject layer and the other layer referred to or between the subject layer and one or both of the layers the subject layer is between.

Such a heat-sealing layer would be a layer of a substantially unfoamed, heat-sealable resin or blend of resins, and will provide for an improved heat-sealability of the overall structure.

Said heat-sealing layer will be the upper layer in the end sheet, i.e. the layer that in the tray will be supporting the product to be packaged and will be in direct contact therewith.

Suitable heat-sealing polymers preferably have a melting point $< 140^{\circ}\text{C}$, and preferably $< 130^{\circ}\text{C}$. Such a heat-sealing layer will typically comprise polyethylene homopolymers; heterogeneous or homogeneous ethylene-($\text{C}_4\text{-C}_8$)- α -olefin copolymers having a density $\leq 0.915 \text{ g/cm}^3$; blends thereof with minor amount of polyethylene homopolymers; ethylene-vinyl acetate copolymers; ethylene-acrylic or methacrylic acid copolymers including ionomers; heterogeneous or homogeneous ethylene-($\text{C}_4\text{-C}_8$)- α -olefin copolymers having a density from about 0.915 g/cm^3 to about 0.930 g/cm^3 ; blends thereof with ethylene-vinyl

acetate copolymers or ethylene-alkyl (meth)acrylate copolymers; ethylene-propylene-butene ter-polymers; ethylene-alkyl acrylate-maleic anhydride ter-polymers; and the like polymers.

If necessary or desirable, a tie layer will be present to bond the heat-sealing layer to the polypropylene foam one.

5 In a preferred embodiment of the present invention the thermoformable, multi-layer, co-extruded sheet may also comprise an easy opening feature.

As an example, the heat-sealing layer of the thermoformable sheet may comprise a so-called "peelable" blend. When the thermoformed bottom web, bearing said peelable blend in the upper heat-sealing layer, is sealed to a suitably selected top web, easy opening of the end
10 package is then obtained by separating the two webs at the seal interface by a peeling mechanism.

Alternatively a thin heat-sealing layer may be adhered directly to the foamed polypropylene or to a layer of a polymer with which it has a low bond. In this case the easy opening of the package is obtained by first breaking through the thickness of the thin heat-
15 sealing layer and then delaminating said heat-sealing layer from the underlying support or film.

Still alternatively the easy opening feature is provided by the use of a layer of a blend of only partially compatible polymers having a low internal cohesion. Said low cohesion layer may possibly be coated with a thin heat-sealing layer. Opening of the package in such a case
20 is achieved by internal rupture of the low cohesion layer (and if present of the thin heat-sealing layer first). Examples of blends useful in this alternative easy opening system are described for instance in EP-B-192,131.

It is not necessary that at least one of the outer layers of the thermoformable sheet of the present invention be a layer of "low modulus" foamed polypropylene. It is in fact also
25 possible to coat said polypropylene layer, still by a co-extrusion process, with one or more layers of a thermoplastic foamed or solid material or blend of materials. Said additional layer(s) may be useful for instance to improve the appearance or the properties of the thermoformable sheet, e.g. providing a paper-like appearance or a colored/metallised

appearance or providing the thermoformable sheet with UV absorbing properties, antistatic properties, or slip properties. As the "low modulus" foamed polypropylene layer is always closer to the die cavity than the "high modulus" one, the material that will be present in the outer layer adhered to said "low modulus" foamed polypropylene layer should be selected in
5 such a way to withstand direct contact with the heated cavity die during thermoforming.

One of the advantages of the thermoformable sheet according to the present invention is that it can be obtained by co-extrusion, using a flat die. The use of a flat die and of the flat sheet technology, providing for the calendering of the flat multilayer sheet following extrusion and quenching, allows a better thickness control of the end sheet. An annular die, as
10 required in the physical foaming processes, could however be employed also in this case.

Chemical foaming of the propylene layers is obtained by extruding the resins admixed with the suitable amount of a chemical blowing agent, preferably an endothermic chemical blowing agent.

A chemical foaming agent is a chemical or compound that reacts or decomposes at
15 elevated temperatures, such as those employed in extrusion, to give a product that is normally a gas at atmospheric pressure. The most common chemical foaming agent is sodium bicarbonate with a small amount of citric or tartaric acid as a co-agent. These agents are typically in dry powder form and are dusted or master-batched into the thermoplastic pellets prior to introduction into the extrusion equipment. Proprietary alkali carbonate mixtures
20 suitable as chemical foam agents are those commercialised by Boehringer Ingelheim under the trade name Hydrocerol™ or by Hoechst Celanese under the trade name Hostatron™. Generally these products are sold in the form of master-batches containing about 40 % of foaming agent and said master-batches are added to the polypropylene pellets in an amount typically comprised between about 0.2 and about 3.0 % by weight, preferably between about
25 0.5 and about 2 % by weight. In the co-extrusion process for the manufacture of the thermoformable sheet according to the present invention, the two polypropylene resins need not to contain the same foaming agent or the same amount of foaming agent. Typically the amount of foaming master-batch in a core polypropylene layer will be comprised between

about 0.5 and about 1.5 % by weight, while it will be comprised between about 1 and about 2.5 % by weight if the foamed polypropylene layer is an outer layer.

The invention may be further understood by reference to the following examples that are provided for the purpose of representation and are not to be construed as limiting the scope of the invention. Unless stated otherwise, all percentages, parts, etc. are by weight.

Example 1

The following resins have been co-extruded through a flat die in the sequence reported below. The layer number 1. is the sheet layer that in the thermoforming process is in contact with the heated cavity die. The thickness of each layer in the end partially foamed sheet is also reported between parentheses :

1. Low flexural modulus polypropylene (Montell YX37F sold by Montell – flexural modulus of about 1,200 MPa) blended with 2 % by weight of Hydrocerol™ CF 40 E (350 µm);
2. Modified ethylene-vinyl acetate copolymer (Orevac™ 18211 sold by Elf Atochem) (15 µm);
3. Ethylene-vinyl alcohol copolymer (EVALC F-101 BZ sold by Kuraray) (21 µm);
4. Modified ethylene-vinyl acetate copolymer (Orevac™ 18211 sold by Elf Atochem) (15 µm);
5. High flexural modulus polypropylene (Adstif™ 699 ADXP sold by Montell – flexural modulus of about 1950 MPa) blended with 1 % by weight of Hydrocerol™ CF 40 E (260 µm);
6. Modified ethylene-vinyl acetate copolymer (Orevac™ 18211 sold by Elf Atochem) (20 µm);
7. Blend of 66 % by weight of ionomer (Surlyn™ 1601 sold by DuPont), 24 % by weight of modified ethylene-vinyl acetate copolymer (Elvaloy™ 741A sold by DuPont), and 10 % of polybutene (Polybutene 8640 sold by Shell) (12 µm);
8. Ethylene-vinyl acetate copolymer (Escorene™ UL00909 sold by Exxon) (7 µm).

The co-extruded sheet has been quenched on a chill roll and calendered.

Flexural modulus of the end sheet was about 850 MPa in MD (machine direction) and about 750 MPa in TD (transverse direction).

The density of the end sheet was about 0.7 g/cm³.

Oxygen permeability of the obtained structure was about 1-2 cm³/m².day.atm, when
5 measured at 23 °C and 0 % R. H. according to ASTM D3985.

The thermoformability in-line of the obtained sheet was tested on a Multivac CD 6000 machine for Vacuum Skin Packaging. The thermoforming conditions were as follows :

- forming temperature : 150 °C (with sandwich plate)
- forming pressure : 2.5 bar
- 10 - heating time : 5 seconds
- forming depth : 5 mm, 20 mm, and 27 mm.

In all the three depths tested the results were very good and both corners and grooves were very well defined with no creases or cracks.

CLAIMS

1. A thermoformable, multilayer, co-extruded sheet comprising at least two separate foam polypropylene layers obtained by chemical foaming of two polypropylene resins having different flexural modulus, a "high modulus" polypropylene and a
5 "low modulus" polypropylene.
2. The thermoformable sheet of claim 1 wherein the "low modulus" polypropylene resin has a flexural modulus lower than 1,500 MPa, preferably $\leq 1,400$ MPa, and even more preferably $\leq 1,300$ MPa.
- 10 3. The thermoformable sheet of claim 1 wherein the "high modulus" polypropylene resin has a flexural modulus $\geq 1,500$ MPa, preferably $\geq 1,650$ MPa, and even more preferably $\geq 1,800$ MPa.
4. The thermoformable sheet of claim 1 wherein at least one substantially unfoamed layer is positioned between the two foam polypropylene layers.
- 15 5. The thermoformable sheet of claim 4 wherein the substantially unfoamed layer is a gas barrier layer.
6. The thermoformable sheet of claim 5 wherein the gas barrier layer comprises a polymer selected from the group consisting of ethylene-vinyl alcohol copolymers (EVOH), vinylidene chloride copolymers (PVDC), polyamides, and blends of one
20 or more EVOH and one or more polyamides.
7. The thermoformable, multilayer, co-extruded sheet of claim 1 comprising at least two separate foam polypropylene layers obtained by chemical foaming of two different polypropylene resins having different flexural modulus, a "high modulus" polypropylene and a "low modulus" polypropylene, sandwiching a gas barrier layer
25 comprising a polymer selected from the group consisting of ethylene-vinyl alcohol copolymers (EVOH), vinylidene chloride copolymers (PVDC), polyamides, and blends of one or more EVOH and one or more polyamides, bonded to said foam polypropylene layers by means of tie layers of modified polyolefins.

8. The thermoformable multilayer sheet of claim 7 further comprising a heat-sealing layer adhered on the outer surface of the "high modulus" polypropylene foamed layer, said heat-sealing layer comprising one or more polymers having a melting point $< 140^{\circ}\text{C}$, and preferably $< 130^{\circ}\text{C}$.
- 5 9. The thermoformable multi-layer sheet of claim 8 wherein the heat-sealing layer comprises a polymer selected from the group consisting of polyethylene homopolymers; heterogeneous or homogeneous ethylene-($\text{C}_4\text{-C}_8$)- α -olefin copolymers having a density $\leq 0.915 \text{ g/cm}^3$; blends thereof with minor amount of polyethylene homopolymers; ethylene-vinyl acetate copolymers; ethylene-acrylic or
10 methacrylic acid copolymers including ionomers; heterogeneous or homogeneous ethylene-($\text{C}_4\text{-C}_8$)- α -olefin copolymers having a density from about 0.915 g/cm^3 to about 0.930 g/cm^3 ; blends thereof with ethylene-vinyl acetate copolymers or ethylene-alkyl (meth)acrylate copolymers; ethylene-propylene-butene ter-polymers; ethylene-alkyl acrylate-maleic anhydride ter-polymers; and the like polymers.
- 15 10. A thermoformable, multi-layer, co-extruded, polypropylene foam sheet having a density ranging from about 0.50 to about 0.85 g/cm^3 , preferably ranging from from about 0.60 to about 0.80 g/cm^3 and a flexural modulus higher than 400 MPa .
11. A thermoformed article obtained from a sheet according to any of the preceding claims.

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/EP 99/07338

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B32B5/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Section Ch, Week 9518 Derwent Publications Ltd., London, GB; Class A32, AN 95-136446 XP002095160 & JP 07 060816 A (ACHILLES CORP KK), 7 March 1995 (1995-03-07) abstract	1-3
A	--- WO 91 13933 A (JAMES RIVER CORP) 19 September 1991 (1991-09-19) cited in the application claims 19-24 page 22, line 19 -page 23, line 14 --- -/--	1-9,11

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

Z document member of the same patent family

Date of the actual completion of the international search

6 January 2000

Date of mailing of the international search report

29. 03. 2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Girard, S

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/LP 99/07338

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 263 435 A (SHELL INT RESEARCH) 28 July 1993 (1993-07-28) claims 1-3,7,9 page 3, line 21 - line 26 page 4, line 9 - line 33 example 1 ---	1-9,11
A	EP 0 287 826 A (MITSUBISHI PETROCHEMICAL CO) 26 October 1988 (1988-10-26) column 3, line 54 -column 4, line 18 ---	1-9,11
A	EP 0 841 155 A (JSP CORP) 13 May 1998 (1998-05-13) claim 1 page 4, line 31 - line 49 page 4, line 54 -page 5, line 2 page 5, line 29 - line 40 page 5, line 52 - line 57 -----	1-9,11

INTERNATIONAL SEARCH REPORT

tional application No.
PCT/EP 99/07338

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-9,11 (part.)

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

1. Claims: 1-9, 11 (in part)

A thermoformable, multilayer, co-extruded sheet comprising at least 2 PP foam layers obtained by chemical foaming, and having different flexural modulus; additional functional layers can be present (barrier layer, tie layer, heat-sealing layer). A thermoformed article obtained from such a sheet and referring to any preceding claim is also defined in claim 11.

2. Claims: 10, 11 (in part)

A thermoformable, multilayer, coextruded PP foam sheet having a density in the range of 0.5 to 0.85 g/cm³, and a flexural modulus higher than 400 MPa. A thermoformed article obtained from such a sheet and referring to any preceding claim is also defined in claim 11.

INTERNATIONAL SEARCH REPORT

I. on patent family members

International Application No

P 99/07338

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 7060816	A	07-03-1995	NONE	
WO 9113933	A	19-09-1991	US 5116881 A	26-05-1992
			AT 122701 T	15-06-1995
			CA 2078123 A,C	15-09-1991
			DE 69109860 D	22-06-1995
			DE 69109860 T	26-10-1995
			EP 0520028 A	30-12-1992
			ES 2072606 T	16-07-1995
			JP 2638532 B	06-08-1997
			JP 7266413 A	17-10-1995
			JP 2521388 B	07-08-1996
			KR 9603278 B	08-03-1996
			US 5149579 A	22-09-1992
			US 5180751 A	19-01-1993
GB 2263435	A	28-07-1993	NONE	
EP 0287826	A	26-10-1988	JP 7098349 B	25-10-1995
			JP 63252715 A	19-10-1988
			US 4889669 A	26-12-1989
EP 0841155	A	13-05-1998	JP 10138350 A	26-05-1998
			US 5928776 A	27-07-1999